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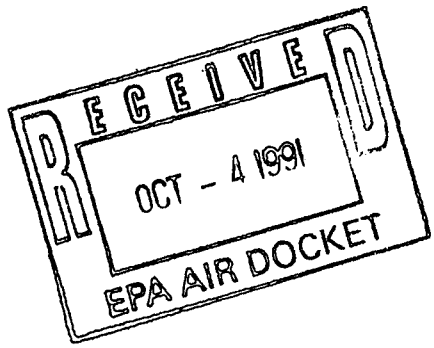


FE-4765
October 4, 1991

U.S. Environmental Protection Agency
Air Docket (LE-131)
Room M-1500
401 M Street, S.W.
Washington, D.C. 20460

Comments of General Motors on
Ethyl Corporation Fuel Additive Waiver Request to
Add HiTEC 3000 to Unleaded Gasoline
Docket No. A-91-46

General Motors Corporation submits the attached comments to the U.S. Environmental Protection Agency (EPA) regarding the Ethyl Corporation fuel additive waiver request for HiTEC 3000, a methlycyclopentadienyl manganese tricarbonyl (MMT) additive. The request asks for EPA approval to add HiTEC 3000 to unleaded gasoline in a concentration of 1/32 gram of manganese per gallon. EPA's notice dealing with the request was published in the August 1, 1991 issue of the Federal Register starting on page 36810.

Based on the discussions in the attachment to this letter, the emissions data presented by the Motor Vehicle Manufacturers Association at the September 12, 1991 public hearing on HiTEC 3000, and the discussions in our response on Ethyl Corporation's 1990 HiTEC 3000 Request (see our reference FE-4573 of July 23, 1990), General Motors is concerned about the adverse impact of HiTEC 3000 as a gasoline additive on emission control system performance.

We believe Ethyl Corporation has not demonstrated that HiTEC 3000 "will not cause or contribute to a failure of any emission control device or system...to achieve compliance by the vehicle with the emission standards...", but in fact demonstrated that HiTEC 3000 will "cause or contribute to a failure of any emission control device or system...". Therefore, we are convinced EPA must deny Ethyl Corporation's request for HiTEC 3000.

Samuel A. Leonard, Director
Automotive Emission Control

Attachment

c: Mary T. Smith

FUEL ADDITIVES
MWJ 081291
10/4/91

COMMENTS OF GENERAL MOTORS ON ETHYL CORPORATION FUEL ADDITIVE WAIVER REQUEST TO ADD HiTEC 3000 TO UNLEADED GASOLINE DOCKET NO. A-91-46

General Motors Corporation offers these comments to the U.S. Environmental Protection Agency (EPA) regarding the Ethyl Corporation (hereafter called Ethyl) fuel additive waiver request for HiTEC 3000, a methlycyclopentadienyl manganese tricarbonyl (MMT) additive. Subsection 211(f) of the Clean Air Act requires approval of such a request in order to introduce a new additive into gasoline. The Ethyl waiver request asks for EPA approval to add HiTEC 3000 to unleaded gasoline in a concentration of 1/32 (0.03125) gram of manganese per gallon. EPA's notice dealing with the Ethyl request was published in the August 1, 1991 issue of the Federal Register starting on page 36810.

The current Ethyl request was filed with EPA on July 12, 1991 (hereafter called the 1991 Request). A similar request was filed with EPA on May 9, 1990 (hereafter called the 1990 Request). EPA published a notice requesting comments on the 1990 Request in the June 5, 1990 issue of the Federal Register starting on page 22947. General Motors responded to the June 5, 1991 notice and submitted comments on July 23, 1990 (see our reference FE-4573 of July 23, 1990). However, the 1990 Request was withdrawn by Ethyl, before the EPA decision date, on November 1, 1990. EPA's notice announcing withdrawal of the 1990 Request was published in the December 20, 1990 issue of the Federal Register on page 52215.

The 1991 Request includes the Ethyl data from the 1990 Request and adds new Ethyl information in response to questions raised in the public comments or by EPA about the 1990 Request. The burden for meeting the Clean Air Act requirements for obtaining a fuel additive waiver is clearly placed upon the applicant. According to Subsection 211(f)(4) of the Act, the burden of proof is with the applicant to show that the additive "will not cause or contribute to a failure of any emission control device or system...to achieve compliance by the vehicle with the emission standards...". It is not up to others to show that the additive will cause or contribute to a failure of any emission control device or system.

The remainder of this attachment discusses various issues about Ethyl's HiTEC 3000 additive which are of interest to General Motors.

Atypical Gasoline Used by Ethyl for Mileage Accumulation

The gasoline used by Ethyl for mileage accumulation in its 48-vehicle fleet was Howell EEE -- a gasoline widely used for conducting emission measurements using the Federal Test Procedure (FTP). However, Howell EEE is not commonly used for mileage accumulation, because it is not typical of U.S. gasoline in terms of its

detergency. Howell EEE does not contain any deposit control detergent additives. In contrast, almost all commercially sold gasoline in the U.S. contains such additives. During 1991, we believe as much as 90-95% of U.S. commercial gasoline contains such detergents. In the future, the use of these detergents will increase to nearly 100% because the 1990 Amendments added Subsection 211(l) to the Clean Air Act. Subsection 211(l) makes it illegal to sell or dispense, after January 1, 1995, "any gasoline which does not contain additives to prevent the accumulation of deposits in engines or fuel supply systems."

The purpose of a deposit control detergent is to keep the engine's intake and fuel system clean, prevent deposits from forming, and thereby help to prevent poor engine operation and to control or reduce engine emissions. Based on past studies, it is clear that excessive carburetor and fuel injector deposits can cause poor engine operation due to improper gasoline metering -- for example, over fueling, under fueling in some cylinders of an engine, improper fuel spray patterns, etc. -- leading to increased engine-out hydrocarbon (HC) and carbon monoxide (CO) emissions. Excessive deposits inside an engine's combustion chambers leads to increased engine-out HC emissions. Any deposit impact can occur with or without the use of HiTEC 3000 in the gasoline. Ethyl's own 48-vehicle fleet results provide good evidence of the impact of the lack of a deposit control detergent in its mileage accumulation gasoline by the fact that Ethyl had to change fuel injectors on many vehicles because of deposits. The quantitative impact of deposits resulting from the use of the non-detergent gasoline on the HC emissions from Ethyl's 48-vehicle fleet is unknown, but could be substantial.

Since the mid-1970s, based on many emission tests on many different engines, Ethyl's MMT additive (now called HiTEC 3000) has been known to increase engine-out and tailpipe HC emissions. Thus, it is not surprising that Ethyl, in its testing for the 1990 and 1991 Requests, reported increased engine-out and tailpipe HC emissions due to the use of HiTEC 3000. However, we believe the lack of detergents in Ethyl's mileage accumulation gasoline may have impacted the magnitude of the HC emission differences due to the use of HiTEC 3000.

The increase in engine-out HC emissions reported and attributed by Ethyl to the use of HiTEC 3000 may have been greater if the vehicles had been fueled with a gasoline containing a deposit control detergent additive. Even without such a detergent in its test gasoline, Ethyl reported an increase in tailpipe HC emissions of 0.010 to 0.018 grams/mile -- not an insignificant increase, but an important increase in comparison to future HC emission standards faced by the auto industry, as will be discussed below.

We believe the waiver applicant for a gasoline additive should test the subject additive using a gasoline containing deposit control detergents typical of current and future gasolines. Ethyl's failure to use such a typical gasoline, that is, one containing deposit control detergents, precludes a determination related to the following:

1. How the use of a gasoline containing both detergents and HiTEC 3000 would

have impacted engine and exhaust system deposits in Ethyl's 48-vehicle fleet.
2. If Ethyl's reported emission results would have been different or the same if a gasoline containing detergents had been used in its test program.

Ethyl simply used the wrong gasoline for mileage accumulation in its 48-vehicle fleet, and this prevents Ethyl from making the necessary showing as required under Subsection 211(f)(4) of the Clean Air Act.

If HiTEC 3000 Is Approved, Future HC Emission Standards Will Become More Stringent

If EPA approves Ethyl's 1991 Request and if HiTEC 3000 is added to gasoline, both in the marketplace and during certification, Ethyl's acknowledged HC emission increase of 0.010 to 0.018 grams/mile (hereafter 0.01 to 0.02 will be used) would effectively make the 1994 and later Federal and California HC emission standards more stringent than enacted by Congress in the 1990 Amendments to the Clean Air Act or adopted by the California Air Resources Board, respectively.

For example, taking into account the HiTEC 3000 HC impact reported by Ethyl, the Federal Tier 1 non-methane hydrocarbon (NMHC) standard of 0.31 grams/mile for 100,000 miles would effectively become 0.29 to 0.30 grams/mile; the Federal Tier 2 NMHC standard of 0.125 grams/mile for 100,000 miles would effectively become 0.105 to 0.115 grams/mile. The effectively more stringent Tier 2 NMHC standard resulting from the use of HiTEC 3000 would be up to 16% lower than the standard set by Congress. These "more stringent" Tier 1 and Tier 2 standards would impact both certification and in-use compliance requirements.

If the Clean Fuel Vehicle standards are met with reformulated gasoline, and if HiTEC 3000 is added to reformulated gasoline -- both in the marketplace and during certification, the 100,000-mile non-methane organic gases (NMOG) standards for the Clean Fuel Vehicle program of 0.156 and 0.090 grams/mile would effectively become 0.136 to 0.146 and 0.070 to 0.080 grams/mile, respectively. Thus, an effective increase in the stringency of up to 22% in the Clean Fuel NMOG standard would occur from the use of HiTEC 3000 in unleaded gasoline.

Similarly, in California, the ULEV NMOG standard for 100,000 miles of 0.055 grams/mile would effectively become 0.035 to 0.045 grams/mile. Thus, an effective increase in the stringency of up to 36 % in the ULEV NMOG standard would occur from the use of HiTEC 3000.

Future Federal and California emissions standards pose very difficult challenges for the automakers. From the discussions above, it is clear that the Ethyl reported increases in HC emissions of 0.01 to 0.02 grams/mile could effectively "cause or contribute to a failure of any emission control device or system...to achieve compliance by the vehicle with the emission standards...".

Claimed NOx Reduction May Not Be Due to HiTEC 3000

In the 1991 Request, Ethyl reported that, on average, vehicles using the HiTEC 3000 additive had tailpipe nitrogen oxide (NOx) emissions 0.11 grams/mile lower after 50,000 miles and the same NOx reduction after 75,000 miles. Without substantiating data, Ethyl claims the lower NOx emissions with HiTEC 3000 were caused by an enhancement of catalytic converter efficiency due to manganese deposits on the catalytic surfaces. However, General Motors conducted tests in the past that showed manganese does not act as a good reducing catalyst.

Another equally plausible explanation for the lower NOx emissions, which would also provide a warning signal of a potential problem caused by HiTEC 3000, could be an increase in exhaust system back pressure. This could have caused an increase in the exhaust gas recirculation (EGR) rate and/or an increase of trapped engine cylinder gases, effectively increasing the engine's EGR rate. An increase in EGR could have reduced engine-out NOx emissions.

Data obtained from Ethyl during the 1990 Request period for the General Motors cars in Ethyl's 48-vehicle fleet program are summarized below and generally support this supposition of reduced engine-out NOx emissions.

Vehicle	Average Engine-Out NOx Emissions at 50,000 miles - g/mi	
	Without HiTEC 3000	With HiTEC 3000
2.0 liter Cavalier	2.79	2.85
2.5 liter Century	1.40	1.31
2.8 liter Century	1.21	1.07
3.8 liter Century	1.96	1.75
Average	1.84	1.74

The average decrease in engine-out NOx emissions for the General Motors cars, 0.10 grams/mile, is almost identical to the average tailpipe decrease, 0.11 grams/mile, reported by Ethyl for its 48-vehicle fleet program.

Ethyl's Corvette Tests Show HiTEC 3000 Increases NOx

In support of its 1991 Request, Ethyl ran durability tests on two 1990 model year Corvettes for 25,000 miles at 100 mph, one without HiTEC 3000 and the other with HiTEC 3000 in the gasoline. The results are reported in Appendix 8 of the 1991 Request and are being used by Ethyl to show that HiTEC 3000 will not plug close-coupled catalytic converters.

However, it should be noted that only about 45 grams of manganese was consumed by the Corvettes operating on HiTEC 3000. In contrast, with a fuel

economy of 20 miles/gallon, in 50,000 miles of customer driving with HiTEC 3000 in the gasoline at a level of 1/32 gram of manganese per gallon, about 80 grams of manganese would enter the engine. For 100,000 miles, the number increases to about 160 grams. Thus, the increasing back pressures reported by Ethyl for the HiTEC 3000 fueled Corvettes may be low in comparison to the full useful life impact.

In addition to reporting exhaust system back pressures in Appendix 8, FTP emission results were also reported by Ethyl. These FTP results show deterioration of the catalysts aged over the accumulation of 25,000 miles.

	Deterioration in Emissions - grams/mile	
	Without HiTEC 3000	With HiTEC 3000
HC	0.056	0.086
CO	1.13	0.46
NOx	0.028	0.308

The increased deterioration of NOx with HiTEC 3000 is about ten times greater than without HiTEC 3000 (0.308/0.028) and corresponds to an additional deterioration of 0.280 grams/mile (0.308 - 0.028) -- a significant increase in comparison to the future Federal Tier 1 and Tier 2 100,000 mile NOx emission standards of 0.6 and 0.2 grams/mile. This is an additional NOx deterioration of about 50% over the low mileage starting NOx value of 0.578 grams/mile (100 x 0.280/0.578) in 25,000 miles -- obviously, a large deterioration and not a HiTEC 3000 caused reduction in deterioration as claimed by Ethyl in both of the 1990 and 1991 Requests.

The above Corvette results also show reduced CO emissions with the use of HiTEC 3000 -- a deterioration over 25,000 miles of 0.46 grams/mile with HiTEC 3000 as opposed to a deterioration of 1.13 grams/mile without HiTEC 3000.

Based on General Motors experience with closed-loop emission control systems, any contamination on an oxygen sensor can slow down the diffusion of oxygen. To a much lesser degree, the contamination can also slow down hydrogen diffusion. In combination, the two diffusion effects cause a lean shift in the air/fuel ratio, that is, having more oxygen in the exhaust gas.

The lean shift occurs in the following fashion:

1. Contamination on the oxygen sensor decreases oxygen diffusion to the sensing element;
2. Decreased oxygen causes a false indication of less oxygen being present in the exhaust gas than is actually present, misleads the closed-loop emission control system, and causes the control system to meter less gasoline into the engine;
3. Less gasoline being metered results in a lean shift increasing NOx and decreasing CO emissions.

We speculate that Mn_3O_4, the main combustion product of the HiTEC 3000 additive, contaminated the oxygen sensor causing a lean shift in the HiTEC 3000 fueled Corvettes. Our past findings of a lean shift impact on emissions caused by contamination agree with the changes in the Corvette emission results reported by Ethyl. As already noted, such a shift would result in decreased CO emissions, but increased NOx emissions. Both effects match Ethyl's emission results reported for the Corvettes.

The gasoline used in the Corvette tests was Super Cetron (an old, no longer used Sohio name for its premium gasoline), a fuel typical of U.S. commercial gasoline because it contained a detergent additive. Thus, because the NOx impact of HiTEC 3000 for the Corvettes is the opposite of the 48-vehicle fleet, fueled without a detergent additive, one can again question the significance of the 48-vehicle fleet results.

48-Vehicle Fleet Test Operation May Not Be Conducive to Plugging

Based on past data, the temperature at the inlet to monolithic catalytic converters is important in determining the propensity to cause plugging with HiTEC 3000. For the 48-vehicle fleet, mileage was accumulated on the road under relatively mild operating conditions. Ethyl reported no evidence of catalytic converter plugging was observed under these conditions, nor during a special test schedule run with one vehicle type.

However, the Ethyl mileage accumulation schedule did not contain much driving that would result in high converter inlet temperatures. In addition, because only one of the eight vehicle types tested had a close-coupled monolithic converter, Ethyl's results may underrepresent the likelihood of converter plugging in the future in the real world due to the use of HiTEC 3000. In the future, it is believed more extensive use of close-coupled catalytic converters will be needed to comply with the Federal Tier 1 and Tier 2 emission standards.

Corvette Conditions May Not Be Conducive to Plugging

Ethyl reported tests on two Corvettes at 100 mph, one without HiTEC 3000 and the other with HiTEC 3000. The Corvettes were equipped with original equipment close-coupled catalytic converters. The implication is that 100 mph in a Corvette is a condition conducive to converter plugging, and if it does not occur then, the use of HiTEC 3000 in gasoline will not plug catalytic converters. We are not sure if Ethyl's implication is true; so we conducted our own tests to determine the severity of the condition.

At 100 mph in fourth gear, the load on a 1990 5.7 liter Corvette engine is not great. Our measurements indicate an engine speed of only 2,450 revolutions per minute and manifold vacuum of about eight inches of mercury. Under those

conditions, the engine was only producing 63 horsepower (hp) -- far less than its rated hp of 245.

Although Ethyl states "[t]he results showed no indication of plugging of the warm-up catalysts..." on the HiTEC 3000 fueled Corvette, the back pressure across the converter after 25,000 miles of driving with HiTEC 3000 increased 0.7 inches of mercury -- about a 4% increase in back pressure. For the baseline Corvette, the back pressure actually decreased about 0.6% over the 25,000 miles. The increase in back pressure with HiTEC 3000 indicates that some degree of plugging occurred over the 25,000 miles. Because converters would plug exponentially, any plugging noted over 25,000 miles might fall far short of the actual plugging that would occur in 100,000 miles of driving.

It should be noted that the engine operating condition most likely to result in converter plugging with HiTEC 3000 is not well understood. It is pretty clear that high temperature exhaust is needed. However, high exhaust flow rate may tend to minimize plugging. Perhaps a high temperature, fairly low space velocity condition is most conducive to converter plugging with HiTEC 3000. That type of condition was not studied by either Ethyl or General Motors.

Claimed HiTEC 3000 Reduction in Reactivity and Toxics May Be Misleading

In the 1991 Request, Ethyl claims the use of HiTEC 3000 would, "...lower reactive hydrocarbon emissions by 23 to 30 percent and lower regulated toxic emissions by 13 to 28 percent" (1991 Request, "Overview," Page 8). The data for three of the gasolines on which the claims are based are not as straightforward as Ethyl indicates. By adding mixed xylenes to these three base gasolines in order to match the octanes of the gasolines containing HiTEC 3000, Ethyl may have biased the test/analysis in favor of HiTEC 3000. We are not sure how much xylenes (perhaps 5 or 10%) were added to the base gasolines, but both the reactivity and toxics emissions are expected to be increased by adding xylenes. Thus, Ethyl was able to claim reductions in reactivity and toxics through the use of HiTEC 3000. In the real world, additional xylenes will not be added to gasoline.

There are much more likely ways to match the octane boost of HiTEC 3000 instead of adding xylenes. For example, methyl tertiary-butyl ether (MTBE) could have been added to the baseline gasolines. Based on data for these three baseline gasolines spiked with xylenes, Ethyl's claimed reductions in reactivity and toxics with the use of HiTEC 3000 have little to do with future trends.

There is only one straightforward comparison in which the addition of xylenes did not cloud the reactivity and toxics issue. However, the HC emissions for the baseline gasoline in this straightforward case were very much higher (0.083 grams/mile) than those for the gasoline containing HiTEC 3000. In fact, for two of the three gasolines spiked with xylenes, the HC emissions for the baseline

gasolines were higher (0.056 and 0.060 grams/mile) than those for the gasolines containing HiTEC 3000.

These decreased HC emissions with the use of HiTEC 3000 is contrary to the results reported elsewhere in the 1991 Request. For example, on Page iv of the "Executive Summary," Ethyl states the use of HiTEC 3000 increases HC emissions by 0.010 to 0.018 grams/mile.

For the straightforward case, the decreased HC emissions, perhaps as large as 0.101 grams/mile (0.083 plus 0.018 grams/mile), contributed greatly to Ethyl's claim of reduced reactivity and toxics through the use of HiTEC 3000. Again, it can be said that Ethyl's claimed reductions in reactivity and toxics through the use of HiTEC 3000 have little to do with reality. Therefore, on an entire fleet basis, reactivity and toxics may actually be higher with the use of HiTEC 3000 than without it, because of higher HC emissions with HiTEC 3000.

If HiTEC 3000 Is Approved, Certification More Complex

If California continues to ban HiTEC 3000, if EPA approves the 1991 Request, and if HiTEC 3000 is added to federal certification gasoline as EPA has proposed in its August 1, 1991 notice about the 1991 Request, there will be added burden to the overall certification process by requiring auto manufacturers to deal with different certification gasolines, one without HiTEC 3000 for California and the other with HiTEC 3000 for EPA.

General Motors Tests Show No Catalytic Converter Enhancement

Since the submission of our comments (our reference FE-4573 of July 23, 1990) on the 1990 Request, we conducted tests evaluating a gasoline containing HiTEC 3000. For these tests, a commercial unleaded gasoline containing 1/32 gram of manganese per gallon was used. The gasoline contained a deposit control detergent, in contrast to Ethyl's 48-vehicle fleet without such an additive. The tests were conducted using 1989-90 vintage 4.3 liter V-6 truck engines. The engines were operated on a General Motors rapid catalytic converter aging cycle (see SAE Paper 881589) for 100 hours. Two close-coupled type ceramic monolithic converters were evaluated, one exposed to HiTEC 3000 and the other not exposed to HiTEC 3000.

It is probably worthwhile at this point to caution that, although a short term test can duplicate 50,000 miles of catalyst aging from a thermal point of view, it cannot expose a catalytic converter to very much HiTEC 3000. This is true because not much gasoline is burned in any 100 hour test. 50,000 miles of customer driving would expose the converter to much more HiTEC 3000 than any 100 hour test. In 50,000 miles of customer driving with HiTEC 3000 in the gasoline at a level of 1/32 gram of manganese per gallon, about 60 grams of manganese would enter the

engine -- much of it depositing on the converter. At 100,000 miles, the amount would increase to about 120 grams. In contrast, only about 9 grams of manganese entered the 4.3 liter engine in our 100 hour test. Thus, it cannot be claimed that the full impact of HiTEC 3000 was measured in our rapid aging tests.

After aging, HC, CO, and NOx conversion efficiencies across each catalytic converter were measured. The two ceramic monolithic converters were evaluated for efficiency (from another point of view, for inefficiency) using three different tests -- a sweep test (see SAE Paper 881598), an engine dynamometer FTP test using a 1.8 liter engine, and a vehicle chassis dynamometer FTP test using a 2.5 liter engine. The average results of two catalytic converters are tabulated below.

Gasolines Used for Converter Aging	Conversion Inefficiency - % HC/CO/NOx		
	Sweep	Engine FTP	Vehicle FTP
Without HiTEC 3000	05/12/17	13/23/21	10/11/23
With HiTEC 3000	06/12/16	14/25/24	10/10/24

The test results show neither the converter aged without HiTEC 3000 nor the converter aged with HiTEC 3000 deteriorated much -- the inefficiencies (100% - efficiency) remained fairly low at the end of the 100 hour test -- values of 25% or less. Note that NOx conversion inefficiency was not reduced by operation on the HiTEC 3000-containing gasoline. The NOx inefficiency was not lower for the HiTEC 3000 aged converter.

Obviously, these findings are contrary to Ethyl's claim of conversion enhancement as stated many times in both the 1990 and 1991 Requests. For example, "...the Additive had no adverse effect on conversion efficiency; rather, the results tended to show increased efficiencies for HC and NOx emissions" (1991 Request, Page 33). General Motors believes the use of HiTEC 3000 will not improve converter efficiency. It very likely reduces converter efficiency because it covers active sites on the catalytic surfaces.

Even Ethyl, in the "Executive Summary" of the 1991 Request, admits no improvement in conversion efficiency as it states, "Analysis of data from these tests shows that conversion efficiency is the same for both clear and Additive-fueled vehicles" (1991 Request, "Executive Summary," Page xiv).

In addition, in other places in the 1991 Request, Ethyl's data show decreases in converter efficiency. For the General Motors engines discussed in Appendix 7 of the 1991 Request, Ethyl's data at a Redox Ratio of 1.0 show a converter inefficiency of 6% (a 94% efficiency as shown on Figure 1 of Appendix 7), (100%-94%) for the clear-fueled car, and 8% (a 92% efficiency as shown on Figure 2 of Appendix 7), (100%-92%) for the HiTEC 3000-fueled car. The inefficiency difference corresponds to a 33% [(6-8)/6] increase in tailpipe HC emissions -- not an insignificant increase as Ethyl indicates. Figures 7 and 8 show similar changes

in converter efficiency at a Redox Ratio of 1. However this time, the HiTEC 3000 caused increase in HC emissions corresponds to 17% -- still not an insignificant increase.

General Motors High Speed-High Load Tests Reveal Potential Converter Plugging with HiTEC 3000

Also, since our July 23, 1990 comments on the 1990 Request, we have conducted some high speed-high load tests with HiTEC 3000-containing gasoline. For these tests, a commercial unleaded gasoline containing a deposit control detergent and HiTEC 3000 in a concentration of 1/32 gram of manganese per gallon was used. Baseline tests were also conducted on a similar gasoline, but without HiTEC 3000. The tests were conducted using two 1989-90 vintage 4.3 liter V-6 truck engines (the same engines used for the rapid aging tests). However this time, the engines were operated at a condition representing high speed-high load.

Such speed-load conditions can be encountered by passenger cars -- trailer pulling and hill climbing on freeways -- and are frequently encountered by light-duty trucks and heavy-duty trucks. General Motors manufactures gasoline-fueled engines for each of these vehicle categories, and if HiTEC 3000 is approved to be added to commercial gasoline in the U.S., each category will likely be operated on gasolines containing HiTEC 3000.

The engine high speed-high load operating condition produced an exhaust temperature of about 900°C at the front face of a close-coupled ceramic catalytic converter. Such a temperature is believed to be representative of converter face temperatures that will likely be encountered starting in the mid-1990s with close-coupled converters. This converter design has been used on Corvettes since the 1987 model year. The tests were run for a duration of 100 hours. After the initial phase, further tests were conducted until the HiTEC 3000-containing test gasoline was consumed. That resulted in having 162 hours of operation on the converter.

At intervals of 25 hours, the HiTEC 3000 converter was removed and examined, and the pressure drop across the converter was measured. The measurements were made at room temperature with an air flow rate of 160 standard cubic feet per minute. The pressure drop results are tabulated below:

Time - hours	Pressure Drop Increase - inches of water Without HiTEC 3000	With HiTEC 3000
0	5.87	6.04
25		6.24
50		7.13
75		7.62
100	6.02 (end)	8.48
125		9.23
150		7.54
162		8.77 (end)

The above data show the converter experienced about a 50% increase in pressure drop over the course of the test. The baseline test shows little pressure drop increase over 100 hours of operation on a gasoline which did not contain HiTEC 3000.

We believe the frequent handling of the converter disturbed some of the HiTEC 3000 deposits, which were scattered throughout the exhaust system and could be easily dislodged.

Also, photos of the front face of the monolithic element were taken at 25 hours intervals and reveal the deposits with HiTEC 3000 can be easily dislodged. We are attaching photos taken at the 0, 75, and 100 intervals with HiTEC 3000. These photos show the accumulation of deposits with HiTEC 3000.

Our baseline test at the same operating condition, but without HiTEC 3000 in the gasoline, showed little deposit accumulation. A photo taken at the end of the baseline test, 100 hours without HiTEC 3000, is attached. Obviously, the use of HiTEC 3000 caused the deposit accumulation observed in the photos referenced above.

We have also attached photos with HiTEC 3000 at the 125 and 150 hours intervals and at the end of the test -- 162 hours. A comparison of photos at 150 and 162 hours shows the rapid accumulation of large flaky deposits. In fact, almost 50% of the cells are covered with such deposits at 162 hours. However, only a few flaky deposits were observed up to 100 hours of testing with HiTEC 3000. The accumulation of these flaky deposits is puzzling; we never encountered such deposits in our previous tests with MMT. Thus, they may or may not be from the use of HiTEC 3000.

MVMA Data Show Large Increases in HC Emissions with HiTEC 3000

The MVMA data, shared with EPA at the September 12, 1991 HiTEC 3000 public

hearing in Arlington, VA, show:
1. Very large increases in HC emissions due to the use of HiTEC 3000,
2. No impact of HiTEC 3000 on CO and NOx emissions.

Ford Motor Company conducted the tests reported by the MVMA at the hearing.

The Ford tests involved four 1991 production Escorts and four 1991 production Explorers, but with prototype 1993-4 air injection pumps on the Explorer engines. The vehicles were operated in pairs. Two of the Escorts and two of the Explorers were operated on a gasoline containing a deposit control detergent and HiTEC 3000 in a concentration of 1/32 gram manganese per gallon. The other four vehicles were operated on the same gasoline with detergent, but without HiTEC 3000.

The vehicles were broken in for 5,000 miles and then put on test for an additional 100,000 miles on a driving schedule which Ford uses as it represents real world driving.

The deterioration in HC emissions for the Escorts and Explorers over the 100,000 miles is summarized below. (The values are based on lease-square fits of the data using the values between 5,000 and 105,000 miles.)

	Deterioration in HC Emissions - grams/mile	
	Without HiTEC 3000	With HiTEC 3000
Escorts	0.08-0.09	0.24-0.37
Explorers	0.08-0.21	0.52-0.76

As shown above, for the Ford test fleet, without HiTEC 3000 in the gasoline, HC emissions deteriorated between 0.08 to 0.21 grams/mile over the 100,000 miles of driving. However, with HiTEC 3000 in the gasoline, the deterioration in HC emissions increased to between 0.24 and 0.76 grams/mile -- 2.5 to 9.5 times higher than the deterioration noted without HiTEC 3000.

Based on the Ford data, there is no doubt that the use of HiTEC 3000 will "cause or contribute to a failure of any emission control device or system...to achieve compliance by the vehicle with the emission standards...". With such a finding, it is clear that HiTEC 3000 cannot meet the requirements of Subsection 211(f) of the Clean Air Act for approval to be added to unleaded gasoline.

Recommendation

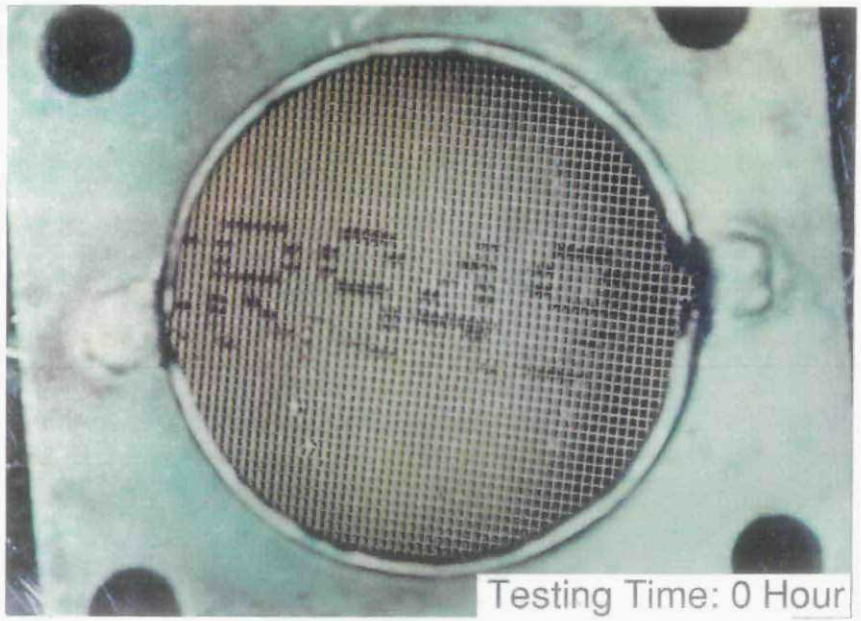
According to Subsection 211(f)(4) of the Clean Air Act, EPA's only task is to determine if Ethyl Corporation has proved that HiTEC 3000 "will cause or contribute to a failure of any emission control device or system...to achieve compliance by the vehicle with the emission standards...". Based on the discussion in these

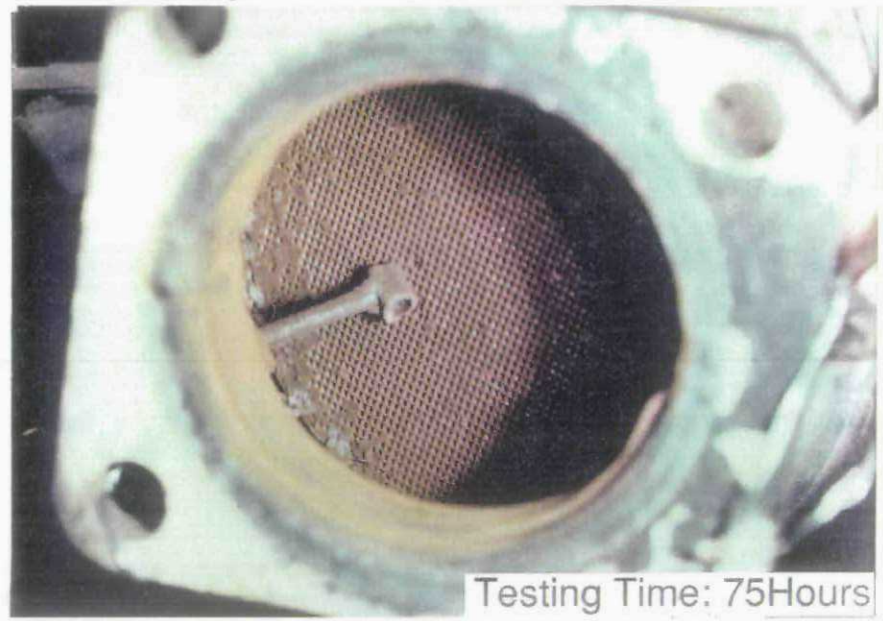
comments, emissions data presented by the Motor Vehicle Manufacturers Association at the September 12, 1991 public hearing, and the discussions in our response on Ethyl Corporation's 1990 HiTEC 3000 Request, General Motors is very concerned about the adverse impact of HiTEC 3000 as a gasoline additive on emission control system performance.

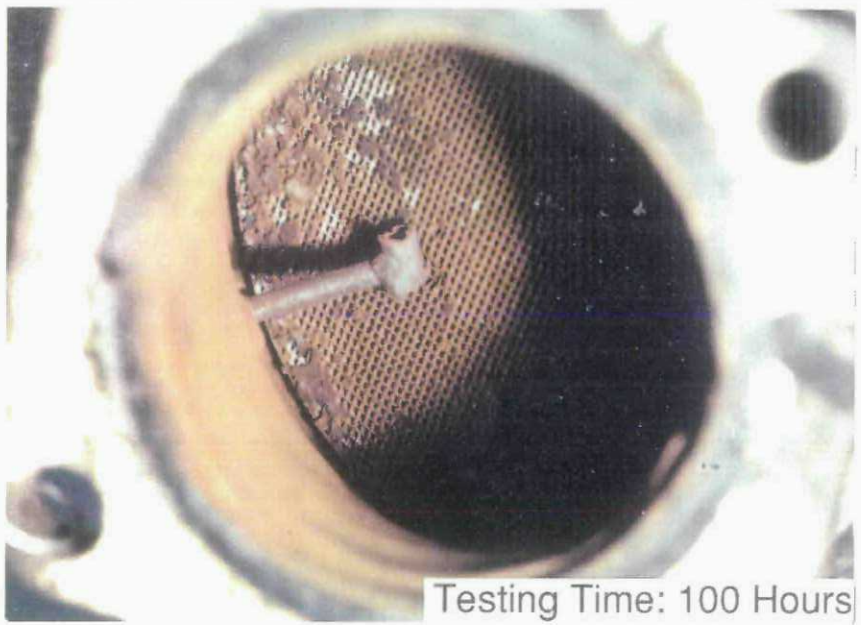
We believe Ethyl Corporation has not demonstrated that HiTEC 3000 "will not cause or contribute to a failure of any emission control device or system...to achieve compliance by the vehicle with the emission standards...", but in fact demonstrated that HiTEC 3000 will "cause or contribute to a failure of any emission control device or system...". Therefore, we are convinced EPA must deny Ethyl Corporation's request for HiTEC 3000.

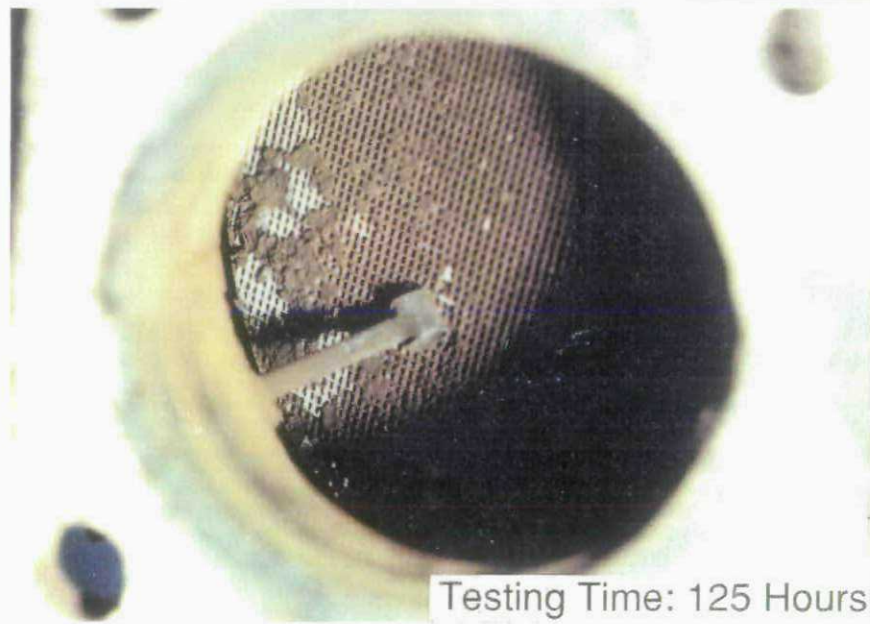
FUEL ADDITIVES
MWJ 081291
10/4/91

High Speed - High Load Tests With HITEC 3000
Corvette Close - Coupled Catalytic Converter

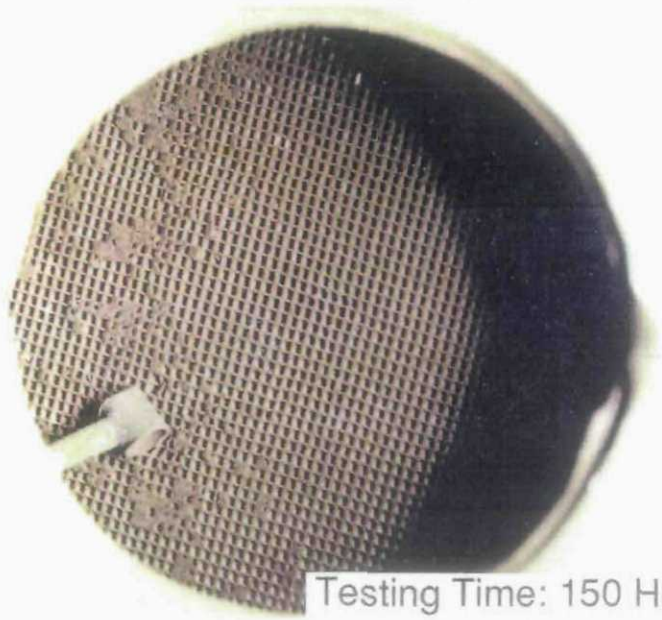

Testing Time: 0 Hour


Testing Time: 75Hours


Testing Time: 100 Hours


Testing Time: 125 Hours

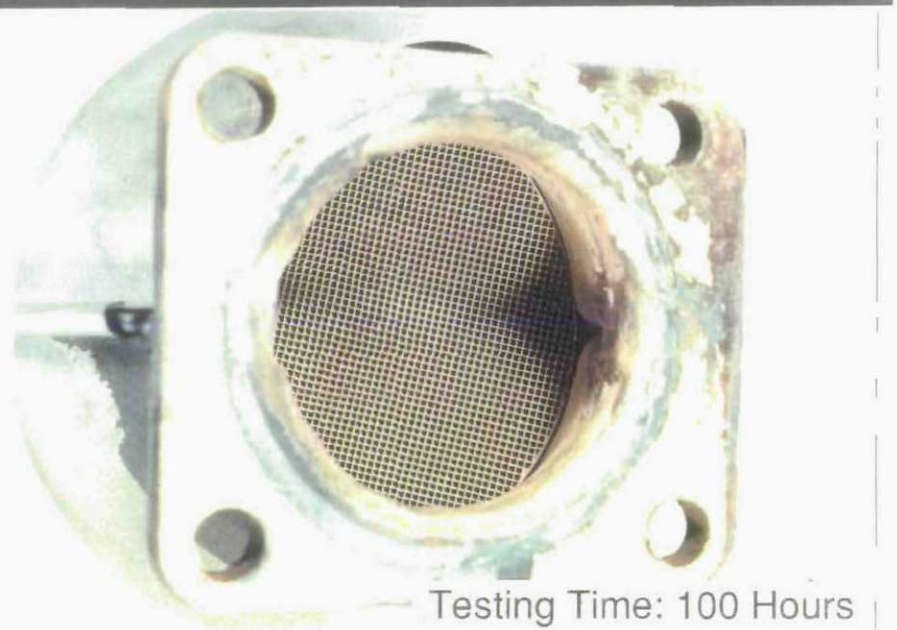
High Speed - High Load Tests With HITEC 3000
Corvette Close - Coupled Catalytic Converter



Testing Time: 150 Hours

Testing Time: 162 Hours

High Speed - High Load Test Without HITEC 3000 Corvette Close - Coupled Catalytic Converter



Testing Time: 100 Hours